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14. ABSTRACT

Report developed under STTR contract for topic AF01T009.
We introduced a new algorithm for the numerical solution of problems of electromagnetic or acoustic scattering in the high-frequency regime. This algorithm combines the use of an ansatz for the unknown density in a boundary integral formulation of the scattering problem with an extension of the ideas of the method of stationary phase.
In particular, we obtained numerical results illustrating the high order convergence of our algorithm as well as its asymptotically bounded computational cost as the frequency increases.

15. SUBJECT TERMS

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"Evaluation of High-Frequency Electromagnetic Scattering via High-Order Multiple-Scattering Integral Asymptotics"

Final Report

October 22 2001-April 21 2003

Mathematical Systems & Solutions Inc.

Oscar P. Bruno, PI

Objectives

To introduce numerical algorithms which, for a given scatterer, compute solutions for arbitrarily high frequencies with a *finite, fixed number of discretization points*, and, thus, within a fixed ($\mathcal{O}(1)$) computational time.

Work performed

High-order high-frequency numerical algorithms were developed and implemented (for simple two-dimensional geometries) as C++ computational codes.

Results obtained

As detailed in the various publications included as part of this report, the results produced by our algorithms include solutions for objects with and without geometrical singularities and for very high frequencies, which were produced within computing times of the order of minutes in single processor computers.

Estimates of technical feasibility

The Phase I one of this STTR award resulted in clear proof-of-concept demonstrations of the proposed high-frequency solvers. We expect our further developments and implementations of these methods, under sponsorship of a newly awarded STTR phase II award, will allow us to generalize our proof-of-concept demonstrations, and to make our algorithms applicable to realistic three-dimensional geometries of interest to the Air Force.

Publications

The results of these efforts were presented in four publications.

1. O. P. Bruno, *Fast, High-order high-frequency integral methods for computational acoustics and electromagnetics*, Topics in Computational Wave Propagation, M. Ainsworth, P. J. Davies, D. B. Duncan, P. A. Martin, B. P. Rynne, eds. 43-82, 2003.

2. O. P. Bruno and C. Geuzaine *A high-order, high-frequency method for surface scattering by convex obstacles*, To appear in the proceedings of Compumag03 "The 14th Conference on the Computation of Electromagnetic Fields"

3. O. P. Bruno, *New high-order, high-frequency integral methods in computational electromagnetism,* To apear in Computer Modeling in Engineering & Sciences, Special Issue on CEM

4. O. P. Bruno, *Wave scattering by inhomogeneous media: efficient algorithms and applications,* To appear in the Proceedings of the Etopim Conference on "Electrical Transport and Optical Properties of Inhomogeneous Media" July 2002, Snowbird, Utah.

5. O. P. Bruno, C. Geuzaine, J. Monro and F. Reitich *Prescribed error tolerances within fixed computational times for scattering problems of arbitrarily high frequency: the convex case,* Submitted to Proc. Roy. Soc. London.